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INTELLIGENT INFORMATION SYSTEMS: A CONTRIBUTION TO THE NEXT GENERATION NATIONAL HERITAGE INFRASTRUCTURE

Abstract. We present some basic concepts of the Intelligent Information Systems (IIS) and further discuss significant qualitative benefits that the approach may contribute to the national heritage infrastructure development. We focus our attention to one of the mechanisms that is crucial for the most of the foreseen benefits: the collaboration mechanisms for community building. This is due to the highly heterogeneous population of prospective users where diverse communities are expected to emerge over the same global information base. Inter- as well as intra-community collaboration, management, interaction, knowledge sharing and dissemination, heterogeneous information integration, and competence building are all addressed within the introduced Collaborative Semantic Web Portal umbrella paradigm. Also, we stress importance of the end-user development in such environments and discuss some supporting mechanisms. Personalization, authorization and context-sensitive configuration are tested on the developed prototype. Finally, based on the prototype, we identify high potential for applying the same approach to development of extremely robust, transparent distributed storage system based on peer-to-peer (P2P) semantic web.

Keywords. national heritage, collaborative system, collaborative mechanisms, intelligent information systems, semantic web, web 2.0

1. Introduction

Web has de facto became the most widely adopted service for accessing information over Internet and the multimedia service that provides searching and viewing of documents that can include text, pictures, sound, animations and the like. Web is widely used in marketing (presentations and advertising), communication (notifications and questionnaires), publications (bulletins and journals) and business (offers, purchase orders, reservations etc.).

Digitalization of national heritage represents qualitative step forward comparing to the traditional national heritage. The breakthrough is mainly due to the fact that the digitalization enables exponential growth in quality of interaction, widespread adoption, and social interaction—all proven in the digital economy but jet to be witnessed in the national heritage infrastructure. Traditional interaction with the national heritage infrastructure includes visiting museum exhibitions, reading books and catalogs, storing of material artifacts in archives and museum's warehouses, scientific research on the archives, developing specialized expert knowledge and it's presentation to the public. Digitalization of libraries, museums, archives and art galleries, secures for the society a

free, pervasive, seamless, and high-quality access to national heritage. Young people will have possibilities to learn history, art, archeology etc., through immediate interaction with the original source material, while journalists, researchers and scientists will have more natural and easier access to accumulating national heritage knowledge base.

The concept of intelligent information systems provides framework for development of fabric of web-based collaborative systems and services where organizations responsible for development of national heritage infrastructure and people who are interested in using the services can be addressed by social interaction on the national heritage infrastructure development and knowledge accumulation. We address the challenge by developing the Collaborative Semantic Web Portal Prototype – collaborative semantic workspace that brings together people, relevant information, knowledge, interaction, innovative methodologies, and supporting tools.

In Section 2 we give brief introduction into collaborative information systems and collaborative systems. We represent the need for web based collaborative systems in national heritage digitalization in Section 3. In Section 4 we will describe developed Collaborative Semantic Web Portal Prototype over collaborative mechanisms that support it, while we represented our further work as P2P semantic Web for robust distributed storage in Section 5. Finally, Section 6 concludes the paper.

2. Background

Intelligent Information Systems (IIS) represent the next generation of information systems embodying knowledge that allows them to exhibit intelligent behavior, cooperate with users and other systems in problem solving, discovery, access, retrieval and manipulation of a wide variety of multimedia data and knowledge, and reason under uncertainty. Contrary to the traditional information systems, the IIS is no more only passive (collecting information, processing and presenting it in a structured way as a classical information system does) but also open, global, interactive and reflective (it is an integral part of a global environment, it reasons about behavior, communicates and collaborates, has the purpose and mission, etc.) 0. The IIS is:

- A platform that provides all necessary infrastructure for interaction within a community of human participants, other intelligent agents and resources; and
- One of the participants in the community.

Based on the definitions from [2], [4], we may say that an agent participates in interaction, while an intelligent agent is also capable of initiating interaction with human actors or other intelligent agents in some environment. The Intelligent Information System is “intelligent” in a sense that it is a platform for interaction between intelligent agent, human actors, and resources, according to the goals and benefits of each individual. The IIS executes this function by means of acquisition, accumulation and sharing of knowledge. The accumulation over the interactions within the IIS results in constant improvement of the effectiveness of the overall system as well as every individual actor. We consider the facilitating interactions and the growth of the system’s capabilities with growing activity of agents within the system, as two essential ingredients of intelligence. This statement is in accordance with the vision of the Semantic Web as ‘a distributed machine which should function so as to perform socially useful tasks’ [3]. This machine should allow intelligent software agents to understand semantic relationships

between Web resources in order to seek relevant information and perform transactions for humans [2]. Also, the most recent excitement about the principles constituting the foundation of the IIS has been articulated as Web 2.0 [5], [6]. Being more an attitude then a technology [6], Web 2.0 strongly favors the same values and designs that are essential for IIS too.

More and more organizations realize that in order to effectively manage innovation, knowledge generation and sharing are of the crucial importance. There is a continuing pressure to generate new knowledge through collaborative means and manage these actions in a way that will provide innovative and productive actions for the organizations, as the main driving factor of the organizational competitiveness. As a consequence, collaborative systems have recently gained considerable attention [7], with a scale the systems ranging from collaborative teamwork up to the Internet scale initiatives. Collaborative systems represent a virtual place where people are brought together, along with relevant information and tools, in order to get things done and solve their problems. Collaboration increases productivity and enables virtual teamwork [8]. Dynamic collaboration presents significant "fuel" that allows common people to attain uncommon and extraordinary results [9].

3. Need for Web Based Collaborative Systems

The vast amount of information presently produced in the world is in a form of digital data, such as: text, databases, audio, film, images [9]. All of the information represent national heritage in the digital era we live in. The question is how to handle enormous amount of data belonging to the digital national heritage in order to preserve it for future generations and provide transparent access for the wide public.

The rapid adoption of information technology makes preservation of digital heritage a global, worldwide concern. As a consequence, people have witnessed growing need to use tools at a global scale, such as web and resources it offers. By using concepts of the intelligent information systems it is possible to develop collaborative web workspace where national heritage organizations and departments can collaborate and work altogether at a national level. Also, citizens have need for easy access to the national heritage knowledge and for seamless interaction with it in a form of distributed, shared community knowledge. They want access from everywhere and from every place. Internet consists of a huge number of web pages that keeps growing. A high percentage of these pages are storing materials of the kind that we traditionally associate with heritage institutions: electronic journals and articles, newspapers, photographs, catalogues and finding aids, and other information and documents from the public sector. All over the world, there are many initiatives and collaborative projects under development within the national cultural heritage organizations and departments, such as National Archives of Singapore, the Singapore National Museum, the National Art Gallery of Asia, the National Library of Australia, Sri Lanka, Taiwan or Malaysia, etc. [10]. An overview of initiatives for collaboration among national libraries, museums and archives is given in [11].

4. Collaborative Semantic Web Portal

Our approach to addressing the need for global, web based collaborative systems for national heritage digitalization is Collaborative Semantic Web Portal Prototype (CSWP). The CSWP is aimed to support inter- as well as intra-community collaboration, workflow and process management, interaction, knowledge sharing and dissemination, and heterogeneous information integration. We believe that collaboration among actors and organizations that are responsible for any single aspect of the national heritage is of the crucial importance for the national heritage digitalization. Without collaboration between different organizations we will have closed process limited within each individual organization. Contrary, using collaboration organizations that are included in activities relevant for national heritage digitalization will have unique collaborative workspace and will collect and store digitalized national heritage data. That system will include data from the national archives, museums and libraries. Also, all data will be accessible globally, all the time, to anyone who is interested in our national heritage.

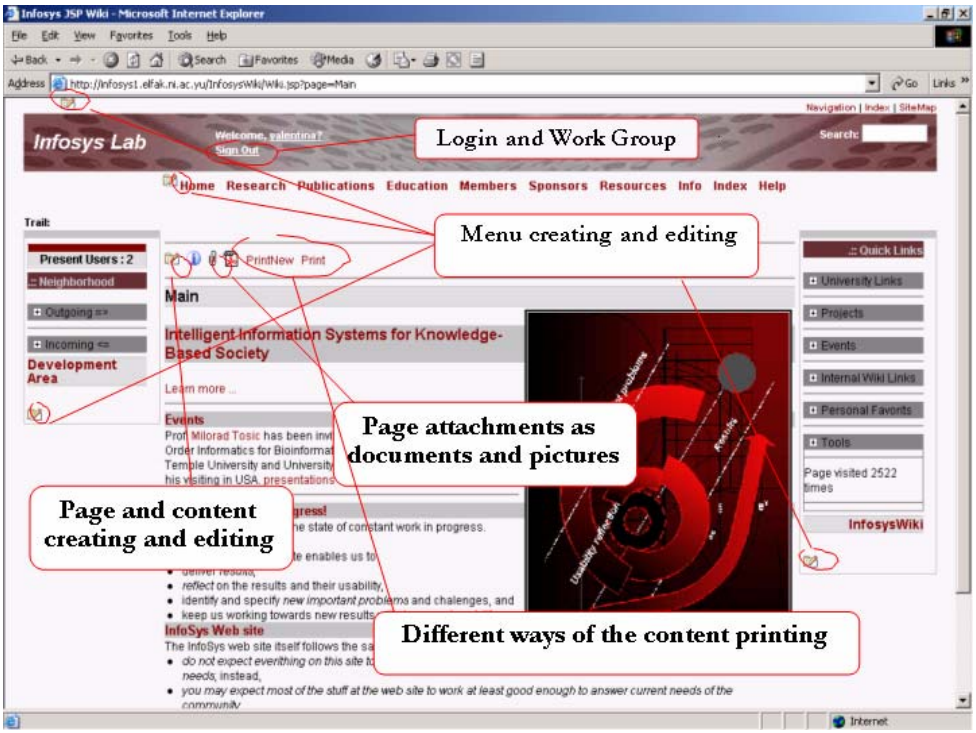

Fig. 1 Collaborative Semantic Web Portal Prototype

In the following, we recognize several collaborative mechanisms important for support to national heritage digitalization. For each of the proposed mechanisms, we briefly present relevant features. Comprehensive discussion of the collaborative system mechanisms is out of the scope of the paper (for more details see e.g. [12]). But, the most important is that all of the mechanisms are evolving and being continuously tested in everyday practice within our Collaborative Semantic Web Portal Prototype (0). Some of the most important concepts are:

System login and working groups,
Interaction over content,
Interaction over structure,
Interaction over presentation semantics.

System login is very important for the system. We defined several permissions for users and working groups: VIEW page content; EDIT page content; PRINT page content; CREATE new page; and ATTACHMENTS per page. Without defined permissions and working groups anyone will be able to edit page's content and to create pages. In such a setting, system and work within organization can't be safe. For example, a rule may be that everyone may be granted access for view to fully processed information, but unfinished part of the data may be viewed and edited only by the specified workgroup working on it. This rule can be changed by the workgroup, if the workgroup has some other needs. 0 illustrates how user that doesn't have privileges to view page content gets login error message.

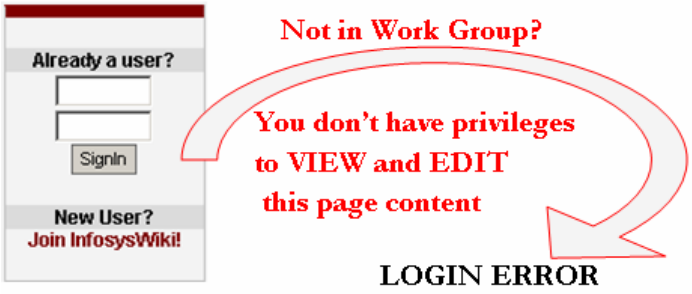

Fig. 2. System login and working groups

As soon as the user is logged in and granted the proper permissions, he/she may edit page content and change it. Several users can interact over the same content and work on the same data, as shown in 0. If users edit page in different time instants there would not raise any conflict situation. If two users are editing page simultaneously, system solves the conflict as follows: Let user A start editing page first and has not yet saved content modifications. Then, user B starts editing the same page. User B gets message from the system that user A has started editing the page, but has not yet saved changes. If user B tries to save modifications first, the modifications would be actually saved. After that, when user A tries to save his/her modifications, the system will send message that someone has modified the page while he/she was editing the page together with the differences between modified and saved version of the text. Now, it is up to the user A to decide which version of the text to keep for saving or whether to modify content again according to the differences from the saved version.

Text formatting rules are defined and explained in the system help. For example, if before and after word "example" we put "__" ("__example__") we will get bolded word example. Also, content can be organized by means of invisible tables. Images can be also included in content. Tables are suitable for example for image galleries. Pages support attachments, and using this possibility figures, document and other files can be uploaded and presented to public. Formally speaking, a page may represent the scope for its attachments. There is possibility to replace one file with newer one, and several

users can work on the construction of the same file. Using formatting rules, we can create a content carrying pictures, figures galleries, books, articles library, and other national heritage data formats.

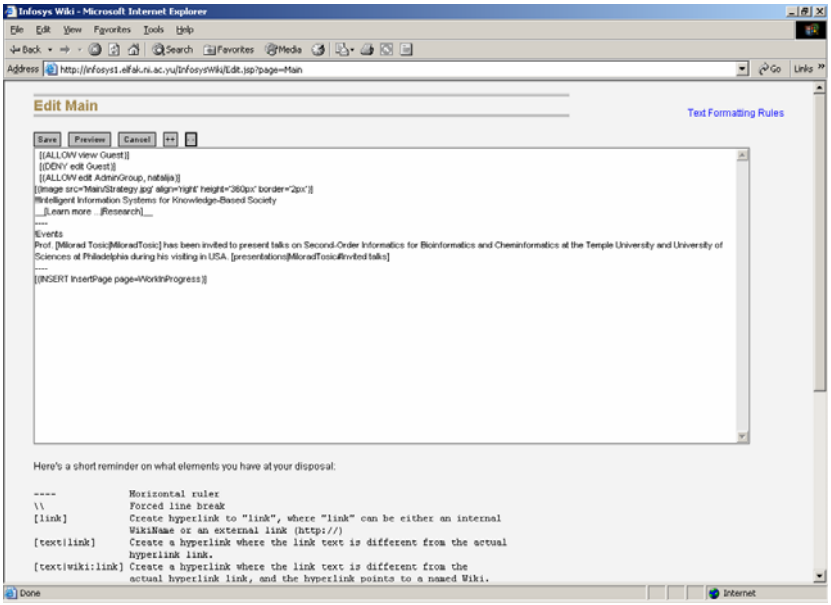

Fig. 3. Interaction over content: Collaborative page editing

The system offers several printing formats, such as: pretty printing, pure text printing, PDF printing and MS Word printing. 0 gives example of pretty printing. Printing feature is appropriate for visitors that want to print content without headers, menus and all unnecessary data.

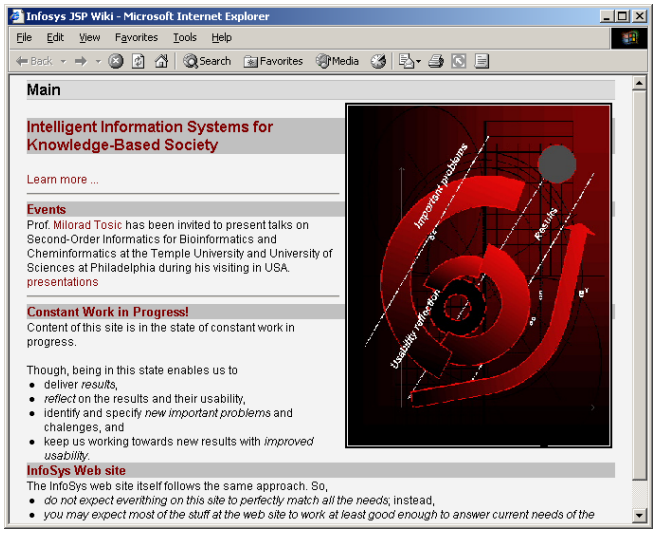

Fig. 4. Interaction over content: Content printing

Interaction over structure is represented by means of automatic set of page neighborhood links (links pointing to the page and links pointing from the page shown in 0) and

useful drop-down menus, as well as page-specific menus reflecting current context. Page neighborhood links are useful for content but even more for semantic map navigation. Interaction over presentation semantics is also represented by importing inter- and intra-web pages or their parts into page content (see 0). User can build the page by composing parts of some other pages within the system or some other web pages found somewhere on the Internet.

In accordance with the Web 2.0 philosophy [5], [6], our system represents the platform for mash-up, personalization and configuration of different existing applications. 0 shows representation of JMol package (the package for 3D representation of molecule structure [13]) that is imported in the system.

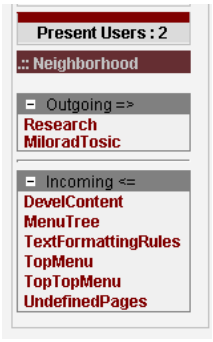

Fig. 5. Interaction over structure: Automatic Links

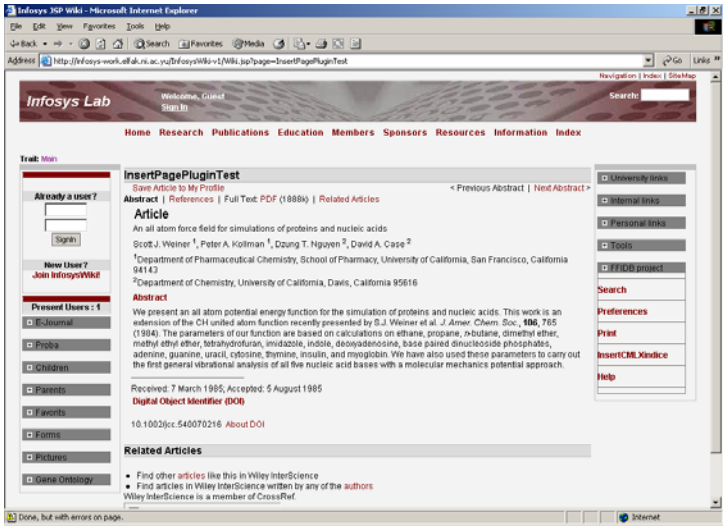

Fig. 6. Interaction over presentation semantics: Importing inter and intra web pages or their some part into page content

We developed Collaborative Semantic Web Portal Prototype [13] and we use it extensively for personal knowledge management, group knowledge interaction, and project management on several projects for: 1) interactive distributed meeting minutes administration; 2) project knowledge accumulation; 3) location-independent access to shared project's documentation; 4) collaborative reports writing; 5) adaptable workspace and automatic e-mail notification about changes in the shared workspace. Also, we use it in education where it has resulted in improved student-teacher communication, students are becoming more active and management of the course becomes more natural. Our initial experience shows that project participant's motivation factor is increased; team communication is improved; management of the project is more natural; continuous monitoring is easier and project information is available to all project members. We believe that similar system can be exploited for national heritage acquisition.

5. Further work: P2P Semantic Web for Robust Distributed Storage

As digitalized national heritage data has become growing rapidly, it's became necessary to insure safe and secure storage of huge amount of data. Using P2P semantic Web concept, national heritage data storage infrastructure can be established and we will have eternal system. P2P networks have become an extremely popular mechanism for large-scale content sharing [14]. There are currently many projects aimed at constructing

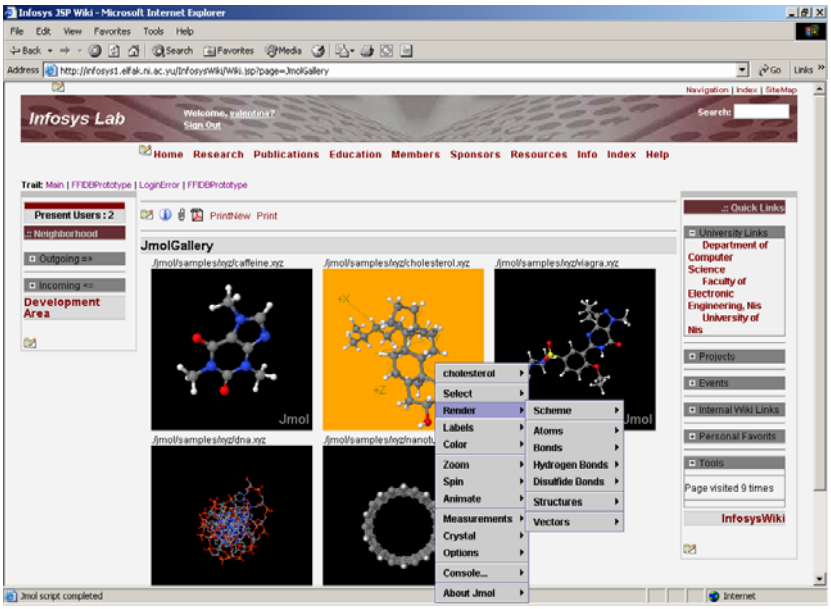

Fig. 7. Interaction over presentation semantics:
Personalization and configuration of several existing applications

P2P applications. P2P systems can be characterized as distributed systems in which all nodes have identical capabilities and responsibilities and all communication is symmetric [15]. 0 shows example of P2P network and self-organizing complex system that may be applied for storage and semantic collaboration. The system could efficiently multiplex resources and connectivity of its nodes across all of its users while at the same time protecting its users from failures in a subset of its components. Precisely, if connection between nodes somewhere fails or any node fails, the system wills not crash. We envision P2P global storage system that aims to provide strong data persistence, high availability, scalability and security.

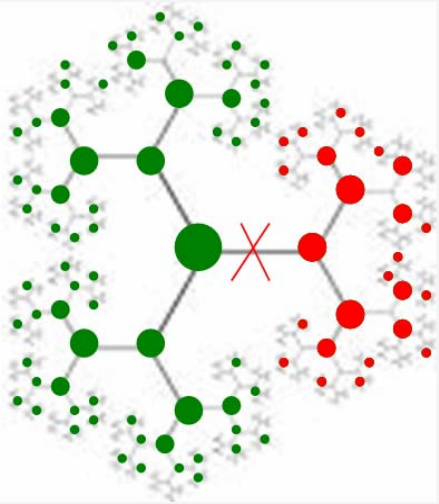

Fig. 8. Self organizing complex system for
"storage–for–forever" and semantic collaboration

6. Conclusion

In this paper, we identify collaborative aspects of Intelligent Information Systems as one of the driving factors of any feasible solution for national heritage digitalization. We developed Collaborative Semantic Web Portal Prototype and discussed supported collaborative mechanisms. Also, we identify distributed storage system based on P2P semantic Web as a strategic feature for future national heritage infrastructure development.

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**ИНТЕЛИГЕНТНИ ИНФОРМАЦИОНИ СИСТЕМИ:
ДОПРИНОС ИЗГРАДЊИ ИНФРАСТРУКТУРЕ НОВЕ ГЕНЕРАЦИЈЕ
ЗА ОЧУВАЊЕ НАЦИОНАЛНЕ БАШТИНЕ.**

Сажетак Разматрају се најважнији појмови интелигентих информационих система (IIS) и њихов потенцијални квалитативни допринос развоју инфраструктуре за очување националне баштине. Посебна пажња је посвећена механизмима који су од пресудне важности за постизање уочених предности овог приступа: колаборативни механизми за успостављање заједнице као оквира међусобне сарадње ради постизања неког заједничког циља. Ово је од велике важности због изразито хетерогене структуре потенцијалних група корисника који користе исту глобалну информациону основу. Колаборација и заједнички рад, менаџмент, интеракције, размена и ширење знања, интеграција хетерогених информација, као и изградња компетентности, како у оквиру једне заједнице тако и између више локалних заједница, разматрани су у контексту парадигме колаборативног семантичког Web портала. Такође, наглашен је значај могућности непосредне интервенције крајњег корисника на конфигурацију и понашање апликације и дискутују се механизми за подршку оваквом приступу. Персонализација, ауторизација, и контекстно зависна реконфигурација су тестиране на развијеном прототипу. У току развоја прототипа, уочили смо велике могућности примене овог приступа на нову важну област развоја екстремно поузданог а за кориснике неприметног дистрибуираног система за дуготрајно чување података заснованог на партиципативном (P2P) семантичом web-у.

Кључне речи: национална баштина, колаборативни систем, колаборативни механизми, интелигентни информациони системи, семантички web, web 2.0

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